REMARKS

Applicant has carefully reviewed and considered the Office Action mailed on February 15, 2002, and the references cited therewith.

Claims 51, 53, 55, 56, 60, 66, 73, and 78 are amended, no claims are canceled, and no claims are added; as a result, claims 51-56 and 60-85 remain pending in this application.

§102 Rejection of the Claims

Claims 51 and 53 were rejected under 35 USC § 102(a) as being anticipated by Kirlin et al. (U.S. 6,320,213).

The rejection states:

> Kirlin teaches a TiSiN or TiAlN layer overlying the walls and exposed base layer of a contact hole, as well as a tungsten or aluminum fill coupled to the titanium alloy layer (col 10, lines 26-28; col 2, lines 29-31), wherein the insulating layer is silicon dioxide.

Kirlin appears to show a TiSiN or TiAlN barrier layer 322. Kirlin appears to teach the importance of choosing a nitride alloy in Col. 9, lines 10-24, where more than 24 compounds are listed that contain nitrides. The nitride barrier layers of Kirlin appear to be necessary to block the diffusion of oxygen (Col. 9, lines 7-9). Kirlin does not include an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole.

In contrast, embodiments of Applicant's titanium alloy layers are designed for lowering contact resistance. Applicant's claims 51, 53, 55, 56, 60, 66, 73, and 78 as amended each include an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole.

Because the Kirlin reference does not show every element of Applicant's claims, a 35 USC § 102(a) rejection is not supported. Reconsideration and withdrawal of the rejection is respectfully requested.

§103 Rejection of the Claims

Claim 52 was rejected under 35 USC § 103(a) as being unpatentable over Kirlin as applied to claim 51 above, and further in view of Ohta et al. (U.S. 5,229,643).

The rejection states:

> Kirlin teaches the above structure but is silent with respect to using zinc as an alternative alloy material. Ohta teaches a CVD method of depositing titanium using zinc as a conductor in a semiconductor device.

Ohta does not cure the deficiencies of Kirlin. Additionally, Ohta appears to include zinc and titanium in a list of 25 possible deposition materials in Col. 10, lines 49-54 as noted by the Examiner. Applicant is unable to find any teaching in Ohta to specifically combine titanium and zinc aside from suggesting trial and error from the extremely large number of hypothetical combinations of the 25 materials in the list. Further, the process from Ohta is used to form a heat radiating portion 15 that possesses *heat* conductivity properties (Col. 10, line 56), not *electrical* conductivity properties.

In contrast, Applicant's claim 52 incorporates an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole. Because the cited references, either alone or in combination, do not show every element of claim 52, a 35 USC § 103(a) rejection is not supported by the references. Reconsideration and withdrawal of the rejection is respectfully requested.

Claims 54-56 were rejected under 35 USC § 103(a) as being unpatentable over Kirlin as applied to claim 53 above, and further in view of Dixit et al. (U.S. 4,884,123).

The rejection states, "with respect to claims 54-56, Kirlin teaches the above structure but is silent with respect to a TiN layer interposed between the titanium alloy and the fill."

Dixit does not cure the deficiencies of Kirlin. Additionally, the layer 322 referred to in Kirlin is referred to as a diffusion barrier layer. The layer 20 of Dixit is also referred to as a barrier layer (Col 4, lines 22-23). Applicant respectfully submits that one skilled in the art would not be motivated to combine two redundant diffusion barrier layers together as the Examiner's combination of Kirlin and Dixit appears to suggest.

The cited references, either alone or in combination, do not show every element of claims 54-56. Therefore, a 35 USC § 103(a) rejection is not supported by the references. Additionally, Applicant is unable to find any motivation in either document to combine the references. Reconsideration and withdrawal of the rejection is respectfully requested.

Claims 60, 62-66, 68, 70-73, 75, 77-79, and 81-85 were rejected under 35 USC § 103(a) as being unpatentable over Kirlin in view Dixit, and further in view of Todorobaru. Claims 61, 67, 74, and 80 were rejected under 35 USC § 103(a) as being unpatentable over Kirlin in view Todorobaru, and further in view of Ohta. Claims 69 and 76 were rejected under 35 USC § 103(a) as being unpatentable over Kirlin in view of Todobaru as applied to the claims 66 and 73 above, and further in view of Doan et al. (US 5,976,976).

Neither Todorobaru nor Doan cure the deficiencies of Kirlin, Ohta, and Dixit. Because the cited references, either alone or in combination, do not show every element of Applicant's claims, a 35 USC § 103(a) rejection is not supported by the references. Reconsideration and withdrawal of the rejection is respectfully requested.

Conclusion

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney (612- 373-6944) to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Commissioner of Patents, Washington, D.C. 20231, on this 15th day of May, 2002.

Name Amy Moriarty

Signature _____

Docket No. 303.676US5 Micron Ref. No. 92-0560.06
WD #394631

Clean Version of Pending Claims

CHEMICAL VAPOR DEPOSITION OF TITANIUM
Applicant: Gurtej Singh Sandhu et al.
Serial No.: 09/941,125

Claims 51-56 and 60-85, as of May 15, 2002 (date of response to first office action filed).

51. (Amended) A via, comprising:
an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole; and
a fill coupled to the titanium alloy layer, wherein the fill comprises a metal selected from the group consisting of tungsten and aluminum.

52. The via of claim 51, wherein the titanium alloy layer comprises titanium and zinc.

53. (Amended) A via, comprising:
an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole, wherein the titanium alloy layer comprises titanium and an element selected from the group consisting of zinc, cadmium, mercury, aluminum, gallium, indium, tin, silicon, germanium, lead, arsenic and antimony; and
a fill coupled to the titanium alloy layer, wherein the fill comprises a metal selected from the group consisting of tungsten and aluminum.

54. The via of claim 51, further comprising a titanium nitride layer interposed between the titanium alloy layer and the fill.

55. (Amended) A via, comprising:

an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole;

a fill comprising a metal selected from the group consisting of tungsten and aluminum; and

a titanium nitride layer interposed between the titanium alloy layer and the fill.

56. (Amended) A via, comprising:

an electrically conductive, nitride-free titanium alloy layer formed overlying walls and an exposed base layer of a contact hole, wherein the titanium alloy layer comprises titanium and an element selected from the group consisting of zinc, cadmium, mercury, aluminum, gallium, indium, tin, silicon, germanium, lead, arsenic and antimony;

a fill comprising a metal selected from the group consisting of tungsten and aluminum; and

a titanium nitride layer interposed between the titanium alloy layer and the fill.

60. (Amended) A via, comprising:

a first layer of an electrically conductive, nitride-free titanium alloy within a contact opening in an insulating layer, wherein the titanium alloy comprises titanium and an element selected from the group consisting of zinc, cadmium, mercury, aluminum, gallium, indium, tin, silicon, germanium, lead, arsenic and antimony;

a second layer of titanium silicide coupled to the first layer; and

a fill coupled to the titanium alloy layer, wherein the fill comprises a metal selected from the group consisting of tungsten and aluminum.

61. The via of claim 60, wherein the first layer includes a titanium zinc alloy.

62. The via of claim 60, further including a titanium nitride layer interposed between the titanium alloy layer and the fill.

63. The via of claim 60, wherein the first layer is coupled to a sidewall of the contact opening.

64. The via of claim 60, wherein the second layer is coupled to an exposed semiconductor surface.

65. The via of claim 60, wherein the contact opening includes a high aspect ratio contact opening.

66. (Amended) A via, comprising:
a first layer of an electrically conductive, nitride-free titanium alloy within a high aspect ratio contact opening in an insulating layer, wherein the titanium alloy comprises titanium and an element selected from the group consisting of zinc, cadmium, mercury, aluminum, gallium, indium, tin, silicon, germanium, lead, arsenic and antimony;
a second layer of titanium silicide coupled to the first layer; and
a fill coupled to the titanium alloy layer, wherein the fill comprises a metal selected from the group consisting of tungsten and aluminum.

67. The via of claim 66, wherein the first layer includes a titanium zinc alloy.

68. The via of claim 66, further including a titanium nitride layer interposed between the titanium alloy layer and the fill.

69. The via of claim 66, wherein the insulating layer includes borophosphous silicate glass (BPSG).

70. The via of claim 66, wherein the insulating layer includes silicon dioxide (SiO_2).

71. The via of claim 66, wherein the first layer is coupled to a sidewall of the high aspect ratio contact opening.

72. The via of claim 66, wherein the second layer is coupled to an exposed semiconductor surface.

73. (Amended) A via, comprising:
a first layer of an electrically conductive, nitride-free titanium alloy on a sidewall of a high aspect ratio contact opening in an insulating layer, wherein the titanium alloy comprises titanium and an element selected from the group consisting of zinc, cadmium, mercury, aluminum, gallium, indium, tin, silicon, germanium, lead, arsenic and antimony;
a second layer of titanium silicide formed overlying an exposed semiconductor base layer of the contact hole;
a fill coupled to the titanium alloy layer, wherein the fill comprises a metal selected from the group consisting of tungsten and aluminum.

74. The via of claim 73, wherein the first layer includes a titanium zinc alloy.

75. The via of claim 73, further including a titanium nitride layer interposed between the titanium alloy layer and the fill.

76. The via of claim 73, wherein the insulating layer includes borophosphous silicate glass (BPSG).

77. The via of claim 73, wherein the insulating layer includes silicon dioxide (SiO_2).

78. (Amended) A via, comprising:

a first layer of an electrically conductive, nitride-free titanium alloy within a contact opening in an insulating layer, wherein the first layer is produced using a method including:

forming a seed layer supported by a substrate by combining a first precursor with a first reducing agent;

forming the titanium layer supported by the substrate by combining a titanium-containing precursor with the seed layer; and

filling the remaining space of the contact opening with a metal selected from the group consisting of tungsten and aluminum.

79. The via of claim 78, wherein the first layer titanium alloy includes titanium and an element selected from the group consisting of zinc, cadmium, mercury, aluminum, gallium, indium, tin, silicon, germanium, lead, arsenic and antimony.

80. The via of claim 78, wherein the first layer titanium alloy includes titanium and zinc.

81. The via of claim 78, further including a second layer of titanium silicide coupled to the titanium alloy.

82. The via of claim 78, further including a titanium nitride layer interposed between the first layer and the fill.

83. The via of claim 81, further including a titanium nitride layer interposed between the second layer and the fill.

84. The via of claim 78, wherein the first layer is coupled to a sidewall of the contact opening.

85. The via of claim 78, wherein the first layer is coupled to a high aspect ratio contact opening.